

Problem Statement:

Next generation nuclear power plants have been proposed that will make use of helium gas-cooled graphite pebble-beds. In order to implement this advanced technology, a number of experimental studies and computational simulations must be performed to understand critical thermal-mechanical issues impacting design and safety. The possibility of graphite dust explosions in advanced reactor concepts are of particular concern. The University of Idaho recently received funding from the Department of Energy to study the potential for graphite explosions in next generation nuclear reactors. As part of this research effort, graphite dust representative of that will potentially be produced in next-generation pebble bed reactors must be generated for use in graphite detonation experiments. In this project, the Capstone Design Team will be asked to design, fabricate, and test a system to produce graphite dust under conditions of pressure (up to 7MPa) and temperature (up to 700 C) expected in actual practice. In order to accurately replicate the generation of dust in actual reactors, but on a much smaller (laboratory scale), elements of Design of Experiments and Dynamic Similarity and Scaling will likely be an important element of this work. Furthermore, since the production of fine powders is inherently dangerous, it is envisioned that initial testing will be conducted using a suitable surrogate material. This surrogate material must be chosen on sound thermomechanical principals so that system operation can be verified before progressing to graphite dust generation. In addition, the dust generated within the dust must be collected and its physical characteristics quantified in terms of weight, particle size, and particle size distribution. In summary, this project will expose the Capstone Design Team to various aspects of mechanics, thermodynamics and heat transfer, and gas dynamics relevant to the design of advanced nuclear reactors. It is an excellent opportunity for students interested in nuclear power generation to gain knowledge and exposure in this important field of engineering.